The decrease in direct solar radiation was accompanied by an increase in diffuse sky radiation, as is shown by the Callendar pyrheliometer measurements given in Table 2. May 20 and 26 were smoky days, and June 30 was an unusually clear day. There were practically no clouds on these three days before noon. The measurements were obtained as described and illustrated on pages 139 and 140 of the current volume of this Review.

The Callendar records indicate that from sunrise to noon on June 30 the sky radiation was 12 per cent of the total radiation, while on May 20 and 26 it was 32 per cent and 36 per cent, respectively.

The skylight polarization, measured at a point 90° from the sun and in the same vertical circle, with the sun at zenith distance 60°, was 31 per cent on May 20, 26 per cent on May 26, and 63 per cent on June 30.

It is no doubt due to the hygroscopic character of the particles constituting the smoke that its depleting effect on solar radiation was more marked during the morning, when the air temperature was low, than during the afternoon, when the air was warmer.

PHOTOMETRIC MEASURES OF THE ZODIACAL LIGHT.

By MAXWELL HALL.

[Dated Jamaica, W. I., June 5, 1914.]

1. In a former article on the zodiacal light [1] it was stated that a few observations had been made of the intensity of the light at different distances from the sun, as compared with the light of the sky at the same zenith distance at places as free from stars as possible; more observations of this character were made this year between February 19 and April 26, 1914, when the appearance of the young moon in the west and the commencement of the "May rains" put an end to the series which included both the clearest nights and the greatest brilliancy of the eastern branch of the zodiacal light, as seen in the evening in the west.

The reduction of the observations was commenced about the beginning of April, and although the measures forming any set were as a rule as uniform as could be expected, yet the resulting illuminations were discordant. However, by going through the original observations carefully, by striking out two sets which should not have been made, and by giving weights to all the remaining sets, results were obtained sufficiently good to compare with theory.

The instrument used was a dark-glass wedge about 4½ inches in length attached to the end of a small brass tube about 3½ inches in length and an inch in diameter; the tube was, of course, blackened inside, with a diaphragm near the wedge end so that the field in looking through the other end was as much as 6° in diameter; this reduced the light of the sky at night to a circular patch apparently no larger than the full moon near the zenith. The sharp edge of the tube completely enclosed the eye, thereby cutting off all side light, and the wedge could be easily moved by hand; light was required to read on a scale the position of the wedge which gave extinction of the circular patch, and repeated readings were alternately taken of the zodiacal light at a certain point in its axis, and of the light of the sky about the same altitude as free from the brighter stars as possible.

[1] Bulletin, Mount Weather Observatory, Washington, 1914, 6, pt. 3, p. 69.

Let m and m' be the magnitude of two stars at the same zenith distance, so that their reduction to the zenith is the same; let l and l' be their light, and r and r' their extinction readings on the wedge photometer; then

$$m'-m=c(r-r')=2.5\log\frac{l}{l'},$$

where c is constant for the particular instrument used. Thus

$$\log\frac{l}{l'}=0.4c(r-r');$$

and by observations made of several pairs of stars it was found that $0.4c=0.18$.

Let S_0 be the light of the sky at 30° or more above the horizon on an average fine dark starlight night and r_0 its extinction reading; let S be the light at any time and r_s its reading; then

$$\log\frac{S}{S_0}=0.18\ (r_s-r_0).$$

We shall take S_0 as unity and measure all such light in terms of S_0. The corresponding value of r_0 was taken to be 5.7.

Let L be the illumination at any point in the central axis of the zodiacal light, reduced to the zenith, and let R be the reducing factor; so that $\frac{L}{R}$ is the apparent light at the point in question and $\frac{L}{R}+S$ is the whole illumination of the field of view. We thus get

$$\log\left(\frac{\frac{L}{R}+S}{S}\right)=0.18(r-r_s),$$

where r is the extinction reading of the zodiacal light. This may be written

$$\log\left(\frac{L}{RS}+1\right)=0.18(r-r_s),$$

and we thus get $\frac{L}{RS}$, or N, a known quantity. Finally,

$$\log L=\log N+\log R+\log S \qquad (1)$$

For $\log R$, Seidel's table of the extinction of light by the atmosphere [2] increased by $\frac{1}{6}$ is used; this gives the magnitudes of stars down to 3° or 4° above the horizon to the nearest tenth of a magnitude (using the Revised Harvard Photometry) by a highly refined method adopted at Kempshot, so that it is absolutely correct for the present rough measurements, and, of course, $\log S=0.18(r_s-5.7)$.

The observations and their reductions will be found at the end of this article as formed into groups at different angular distances from the sun. The following are the general results:

Distance from sun. α	Light. L.
35°	7.2 ±0.7
50°	2.4 ±0.3
75°	1.1 ±0.1
100°	0.71±0.2
155°	0.25±0.03
180°	0.42±0.05

It is, however, important that we should obtain L along a line of sight as near the sun as possible, and the

[2] Phil. trans., London, 1873. Seidel's table enlarged is given as Table 5 at the end of this article.

following observations, recorded in the former article, allow us to approach within 21° of the sun.

Date. 1912.	Distance from sun. α	Elevation above horizon.
Sept. 11	20°	3°
23	24°	5°
Oct. 19	20°	3°
20	21°	3°
Means	21°	4°

On these and other occasions it was noticed that the illumination was fairly uniform from about 15° above the horizon down to near the horizon itself. But a point 35° from the sun would be 18° above the horizon when a point 21° from the sun would be 4° above; so that

$$\frac{\text{Light at } 21° \text{ reduced to zenith}}{\text{Light at } 35° \text{ reduced to zenith}}=\frac{R \text{ at } 86° \text{ zen. dist.}}{R \text{ at } 72° \text{ zen. dist.}},$$

so that L at 21° is about 4 times the value of L at 35°, or about 29.

The observed breadth of the zodiacal light at 21° was 32°, but the absorption of the atmosphere will have some effect on its breadth at the small altitude of 4° above the horizon. If 0.2 be the limit at the extreme edge, light amounting to 1.5 has been extinguished at the edge, so that the whole breadth has been diminished by about a tenth, and the true breadth is 35°.

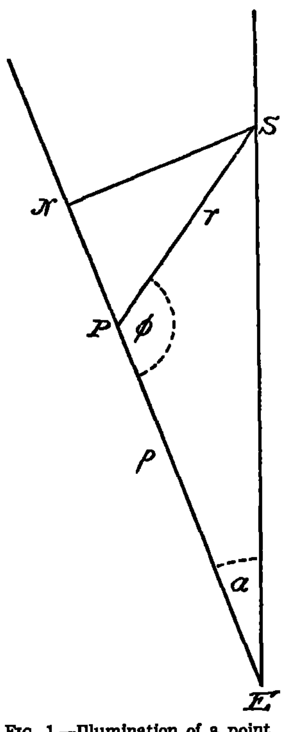

FIG. 1.—Illumination of a point, P, in the zodiacal light, seen from the earth, E, for large values of α.

2. These results naturally lead us to theoretical considerations, and we shall now determine the law of density along the central plane of the zodiacal light which will give the same values of L as those found by observation, or rather, we shall show that this density varies inversely as the square of the distance from the sun.

In figure 1, let the plane of the paper coincide with the central plane of the zodiacal light. Let S and E be the sun and earth, and let P be any point along the line of sight EP.

Taking the length SE as unity, let $SP=r$, $EP=\rho$, and let $\angle SEP=\alpha$, and $\angle SPE=\phi$.

Now considering a single spherical body at P, the illumination of the body would vary as $\frac{1+\cos\phi}{r^2\rho^2}$; but when there are a large number of small bodies their number in the field of view will vary as ρ^2, and also as the density, or their number in an unit volume of space; and as this density is assumed to vary as $\frac{1}{r^2}$ we get

$$\text{Illumination at } P=k\left(\frac{1+\cos\phi}{r^4}\right),$$

where k is some constant. And if L be the whole illumination along EP to the boundary of the zodiacal light,

$$L=k\int_0^{\rho_1}\left(\frac{1+\cos\phi}{r^4}\right)d\rho$$

where ρ_1 is the limiting length of ρ.

In order to integrate, change the independent variable from ρ to ϕ by means of the equations

$$r\sin\phi=\sin\alpha$$
$$\rho\sin\phi=\sin(\alpha+\phi),$$
$$\frac{d\rho}{d\phi}=-\frac{\sin\alpha}{\sin^2\phi}.$$

Thus

$$L=-\frac{k}{\sin^3\alpha}\int_{\pi-\alpha}^{\phi_1}(1+\cos\phi)\sin^2\phi\, d\phi;$$

and integrating,

$$L=\frac{k}{\sin^3\alpha}\left[\tfrac{1}{2}\phi-\tfrac{1}{4}\sin 2\phi+\tfrac{1}{3}\sin^3\phi\right]_{\phi_1}^{\pi-\alpha} \qquad (2)$$

where ϕ_1 is the limiting value of ϕ corresponding to ρ_1, the limiting value of r being 2.1 according to the former article.

But when P is in opposition to the sun, $\alpha=180°$, or π in circular measure; and we must now take r as the independent variable; so that

$$L \text{ at opposition}=2k\int_1^{r}\frac{dr}{r^4}=\frac{2k}{3}\left[\frac{1}{r^3}\right]_{2.1}^{1}$$

or $0.59k$.

We have now to compute L for the different values of α by means of equation (2), taking $k=0.80$ so as to suit the observed light at $\alpha=35°$ and $\alpha=50°$ as nearly as possible. The following are the results:

α	L computed.
21°	27.
35	6.6
50	2.7
75	1.1
100	0.72
155	0.49
180	0.47

The agreement between computation and observation is remarkable, and it proves the truth of the assumption as to the law of density. The computations are given at the end of this article.

3. But as the distance r decreases there must be some limit to the density, and also to the illumination. We know that the light does not greatly increase, because it is not seen during total solar eclipses; nor is it seen during twilight.

If we compute L for $\alpha=10°$ we get $L=240$, which is far beyond the scope of the instrument described above, which can only measure up to $L=13$ or 14; and twilight photometry will require another instrument and a special investigation.

Let us now suppose that the stratum constituting the zodiacal light does not approach the sun nearer than $r=0.358$, corresponding to $\alpha=21°$; the line of sight for $\alpha=10°$ now cuts the limiting circle (see fig. 2), and the integral for L consists of two parts whose sum gives us only 13.

This shows the great effect of the central condensation and the possibility of finding the interior limit of the zodiacal stratum at some future time.

The computations are given at the end of this article.

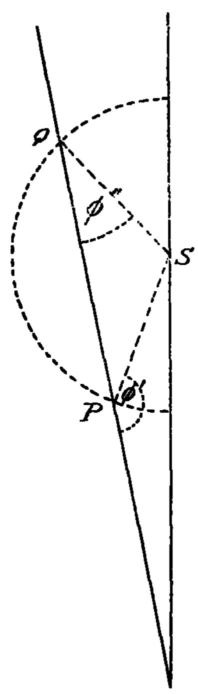

FIG. 2.—Illumination of a point, P, in the zodiacal light, seen from the earth, E, for smaller values of α.

4. We have now to consider the apparent breadth of the zodiacal light as seen from the earth, and the thickness of the stratum of the particles composing it.

With reference to the observed breadths at certain distances from the sun given in the former article p. 64, if we draw a curve through them as in figure 3 we can

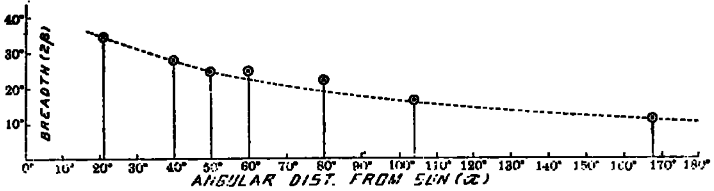

FIG. 3.—Observed breadths, 2β, of the zodiacal light for different values of α.

take from that curve the "observed" breadth at any distance from the sun, and thus get the following half-breadths, which we shall call β.

α	β
°	°
21	17½
35	15
50	13
75	10
100	8
155	6
180	6

In figure 1 draw SN at right angles to EP, so that $SN=r=\sin\alpha$, and $EN=\rho=\cos\alpha$: and let us consider a section of the stratum along the line EN by a plane at right angles to the paper. Let $2h$ be the whole thickness of the stratum at N, so that $h=\rho\tan\beta$.

If we now combine r, ρ, and h at $\alpha=21°$, $35°$, and $50°$, we come to the conclusion that the stratum has a curved surface so that h is greatest when r is least, and so that $h=\dfrac{0.115}{r}$.

The following are the computations:

TABLE 1.—*Computation of* hr.

α	β	r	ρ	h	hr
°	°				
21	17½	0.358	0.934	0.294	0.106
35	15	0.574	0.819	0.220	0.126
50	13	0.766	0.643	0.148	0.114
Mean..	....	....	....	....	0.115

We can go no further than $\alpha=50°$, for as α approaches and exceeds 90° the conditions entirely change; but we can find the relation between r, ρ, and h for any value of α and the corresponding β.

Let r_2, ρ_2, h_2, have the special values which satisfy the given values of α and β; then

$$r_2\rho_2=\frac{0.115}{\tan\beta},$$

and as

$$r_2\rho_2=\frac{\sin\alpha\sin(\alpha+\phi_2)}{\sin^2\phi_2},$$

we have

$$\frac{\sin(\alpha+\phi_2)}{\sin^2\phi_2}=\frac{0.115}{\sin\alpha\tan\beta},$$

an equation which can easily be solved by approximation.

A small difficulty occurs for $\alpha=180°$ because $\sin\alpha$ and $\sin\phi_2$ both vanish; but we have only to find the limiting value of

$$\frac{\sin\alpha\sin(\alpha+\phi_2)}{\sin^2\phi_2}.$$

In figure 1 let $\angle ESP=\psi$; then $\phi_2=\pi-(\alpha+\psi_2)$; and the expression becomes

$$\frac{\sin\alpha\sin(\pi-\psi)}{\sin^2(\alpha+\psi)};$$

and putting $\psi=0$, and $\alpha=\pi$, the limiting value is 1; so that $r_2\rho_2=1$; but as the tangent of 6° is 0.105, $r_2\rho_2\tan\beta=0.105$; and the constant is 0.105 for this end of the curve, while we found 0.115 for the other end.

Consequently we shall take the constant to be 0.110, and consider that the equation

$$h=\frac{0.110}{r} \tag{3}$$

is true for the whole series. The equation for ϕ_2 is now

$$\frac{\sin(\alpha+\phi_2)}{\sin^2\phi_2}=\frac{0.110}{\sin\alpha\tan\beta'}$$

and the computations are here given.

TABLE 2.—*Computation of* r_2, ρ_2, *and* h_2.

a	β	$\frac{0.110}{\sin a\tan\beta}$	ϕ_2	r_2	ρ_2	h_2
°	°		° ′			
21	17½	0.974	84 22	0.360	0.969	0.306
35	15	0.716	101 37	0.586	0.701	0.188
50	13	0.622	91 33	0.766	0.622	0.144
75	10	0.646	70 8	1.027	0.608	0.107
100	8	0.795	51 10	1.264	0.619	0.087
155	6	2.476	15 12	1.612	0.649	0.068
180	6	....	....	1.640	0.640	0.067

Let us now take a section passing through the sun by a plane at right angles to the paper, as along the line SN produced in figure 1. In the following figure, which represents the section of the northern half of the western branch, S is the sun, SA the central axis of the zodiacal light, M any point on the bounding curve LM; so that $SN=r$, and $MN=h$.

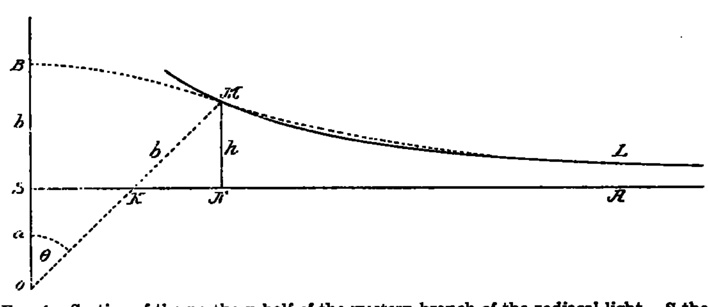

FIG. 4.—Section of the northern half of the western branch of the zodiacal light. S the sun, SA the central axis of the zodiacal light, M any point on the bounding curve, $SN=r$.

Now, provided we do not approach the sun nearer than $\alpha=21°$ or $r=0.358$, the curve given by equation (3) practically agrees with the conchoid of Nicomedes taking $a=0.265$ and $b=0.326$; this is the dotted curve in figure 4 to distinguish it from the former continuous curve; and nothing could have been more useful than this connection if we had to approach the sun, which is more than a matter of doubt; but, on the other hand, the conchoid complicates the relation between h and r to such an extent as to be almost useless among forms for integration.

Thus the polar equation of the conchoid is

$$\text{Radius} = a \sec \theta + b;$$

but retaining the former origin and rectangular coördinates

$$h = b \cos \theta,$$
$$r = a \tan \theta + b \sin \theta,$$

so that

$$r = \left(\frac{a+h}{h}\right)\sqrt{b^2 - h^2};$$

and we shall continue to use equation (3).

5. We must now consider the decrease in the density with the height of any point above the central plane. In figure 4 take any point between N and M at a distance z from N; now we have found that the density at N varies inversely as r^2, and we shall find that the density at the point above N further varies inversely as z, so that

$$\frac{\text{density at point}}{\text{density at } N} = 1 - \frac{z}{h}$$

and we proceed to compute the illumination at such a point as M on the boundary of the zodiacal light as seen from the earth for the different values of α and their corresponding values of β.

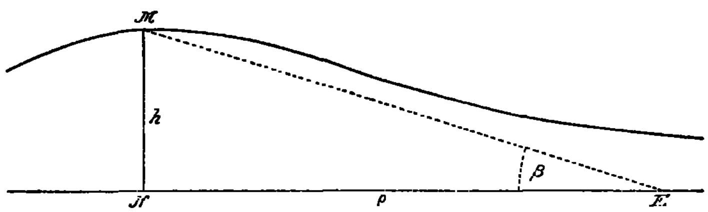

FIG. 5.—A section of the stratum along the line *EPN* of fig. 1, when $\alpha = 21°$ and $\beta = 17\frac{1}{2}°$. The line of sight cuts the surface at M.

Figure 5 is a section of the stratum along the line *EPN* in figure 1, where $\alpha = 21°$ and $\beta = 17\frac{1}{2}°$; and it will be seen that the line of sight cuts the surface at M, so that in integrating along EM the limits are ρ_2 and ϕ_2 corresponding to N.

$$\text{Now } 1 - \frac{z}{h} = 1 - \frac{r\rho \tan \beta}{0.110}$$

$$\text{so that } 1 - \frac{z}{h} = 1 - 9.09 \tan \beta.\ \frac{\sin \alpha \ \sin(\alpha + \phi)}{\sin^2 \phi}$$

and the former expression for L must be multiplied by this expression for $1 - \frac{z}{h}$

Let L_2 be the light along the line EN as far as N, and let L' be the required light along EM; then it may be easily shown that

$$L' = L_2 - \frac{4.54k \tan \beta}{\sin^2 \alpha}\left[\begin{array}{c}\sin \alpha(\phi + \frac{1}{2}\sin 2\phi) \\ + \cos \alpha \sin^2 \phi \\ - 2\cos(\alpha + \phi)\end{array}\right]_{\phi_2}^{\pi - \alpha} \qquad (4)$$

where the limits for L_2 are of course also $\pi - \alpha$ and ϕ_2. The computations are given further on, and the results are:

α °	L'
21	0.92
35	0.21
50	0.22
75	0.26
100	0.28
155	0.30

L' for $\alpha = 21°$ is too large; L' for $\alpha = 35°$ and $50°$ is quite correct according to observations made near $\alpha = 155°$ where the band of light is very faint and without any distinct central condensation, as is also shown by the computed values of L and L' for $\alpha = 155°$.

There is no difficulty about L' for $\alpha = 21°$; a revision of this article would probably put it right.

6. There are also other matters which should receive attention at some future time; the integrals for L do not show the "gegenschein" or counterglow, the small effect of phase near the earth being effaced by the very great distances involved.

Perhaps we should consider the reflection from a certain proportion of bright metallic particles, producing an effect similar to the "anthelion" [glory] which surrounds an observer's head on a dewy lawn under well-known circumstances.

Then there is the question of mass and possible small perturbations. Let m be the whole mass of the particles constituting the zodiacal light; then if D and h be the density and half the thickness at unit distance, and taking 2.1 and 0.3 as the limits of r, we have $m = 6\pi Dh$, nearly.

And for the mass interior to the planets we have

	Interior mass.
Mars	0.9 m
The Earth	0.8 m
Venus	0.7 m
Mercury	0.3 m

This shows that there is a very slight increase in the central attraction from Mercury outwards.

Again, in the case of Mercury more particularly, the interior mass may be regarded as a ring at a certain distance from each planet; and with a for each planet, $e = 0$, $i = 1° \ 35'$, $\Omega = 107°$, we might estimate the secular perturbations of the elements of each planet. For instance, if this ring within the orbit of Mercury was the disturbing cause of the motion of its perihelion which was required by Leverrier many years ago, the mass within the orbit would be about one-third that of Mercury, and therefore m would be about equal to that of Mercury itself.

TABLE 3. A.—*The computation of* L.

α	$\phi=\pi-\alpha$				ϕ_1	$\phi=\phi_1$				$\log \frac{k}{\sin^3\alpha}$	L
	$\frac{1}{2}\phi$	$-\frac{1}{4}\sin 2\phi$	$+\frac{1}{3}\sin^3\phi$	Sum.		$\frac{1}{2}\phi$	$-\frac{1}{4}\sin 2\phi$	$+\frac{1}{3}\sin^3\phi$	Sum.		
°					° ′						
21	1.3875	+0.1673	+0.0153	1.5701	9 50	0.0858	−0.0841	+0.0017	0.0034	1.2401	27.
35	1.2654	+0.2349	+0.0629	1.5632	15 51	0.1383	−0.1314	+0.0068	0.0137	0.6273	6.6
50	1.1345	+0.2462	+0.1499	1.5306	21 24	0.1868	−0.1699	+0.0162	0.0331	0.2503	2.7
75	0.9163	+0.1250	+0.3004	1.3417	27 23	0.2390	−0.2042	+0.0324	0.0672	$\bar{1}.9483$	1.1
100	0.6981	−0.0855	+0.3183	0.9309	27 58	0.2440	−0.2071	+0.0344	0.0713	$\bar{1}.9231$	0.72
155	0.2182	−0.1915	+0.0252	0.0519	11 37	0.1014	−0.0986	+0.0027	0.0055	1.0253	0.49

B.—*The computation of* L_2.

α	$\phi=\pi-\alpha$				ϕ_2	$\phi=\phi_2$				$\log \frac{k}{\sin^3\alpha}$	L_2
	$\frac{1}{2}\phi$	$-\frac{1}{4}\sin 2\phi$	$+\frac{1}{3}\sin^3\phi$	Sum.		$\frac{1}{2}\phi$	$-\frac{1}{4}\sin 2\phi$	$+\frac{1}{3}\sin^3\phi$	Sum.		
°					° ′						
21	1.3875	+0.1673	+0.0153	1.5701	84 22	0.7362	−0.0488	+0.3286	1.0160	1.2401	9.632
35	1.2654	+0.2349	+0.0629	1.5632	101 37	0.8868	+0.0986	+0.3133	1.2987	0.6273	1.121
50	1.1345	+0.2462	+0.1499	1.5306	91 33	0.7989	+0.0135	+0.3330	1.1454	0.2503	0.686
75	0.9163	+0.1250	+0.3004	1.3417	70 8	0.6120	−0.1598	+0.2773	0.7295	$\bar{1}.9483$	0.544
100	0.6981	−0.0855	+0.3183	0.9309	51 10	0.4465	−0.2442	+0.1576	0.3599	$\bar{1}.9231$	0.478
155	0.2182	−0.1915	+0.0252	0.0519	15 12	0.1327	−0.1265	+0.0060	0.0122	1.0253	0.421

C.—*The computation of* L′.

α	$\phi=\pi-\alpha$				ϕ_2	$\phi=\phi_2$				$\log \frac{4.54\,k\tan\beta}{\sin^3\alpha}$	L′
	$\sin\alpha\times(\phi+\frac{1}{2}\sin 2\phi)$	$\cos\alpha\times\sin^2\phi$	$-2\cos(\alpha+\phi)$	Sum.		$\sin\alpha\times(\phi+\frac{1}{2}\sin 2\phi)$	$\cos\alpha\times\sin^2\phi$	$-2\cos(\alpha+\phi)$	Sum.		
°					° ′						
21	0.874	+0.120	+2	2.994	84 22	0.563	+0.925	+0.530	2.018	0.9502	0.92
35	1.182	+0.270	+2	3.452	101 37	0.904	+0.786	+1.454	3.144	0.4710	0.21
50	1.361	+0.377	+2	3.738	91 33	1.203	+0.642	+1.566	3.411	0.1551	0.22
75	1.529	+0.242	+2	3.771	70 08	1.491	+0.229	+1.641	3.361	$\bar{1}.8366$	0.26
100	1.543	−0.168	+2	3.375	17 10	1.360	−0.105	+1.752	3.007	$\bar{1}.7213$	0.20
155	0.346	−0.162	+2	2.184	15 12	0.219	−0.062	+1.971	2.128	0.3299	0.38

D.—*The two computations of* L *for* $\alpha=10°$.

$\alpha=10°$; $\phi_1=4°\ 45'$; $\phi'=151°\ 0'$; $\phi''=29°\ 0'$.

$SP=SQ=0.358$ (see fig. 2, p. 312.) $F=\frac{k}{\sin^3\alpha}$; $\log F=2.1841$.

ϕ	$\pi-\alpha$	ϕ_1	ϕ'	ϕ''
$\frac{1}{2}\phi$	+1.4835	+0.0414	+1.3177	+0.2531
$-\frac{1}{4}\sin 2\phi$	+0.0855	−0.0413	+0.2120	−0.2120
$+\frac{1}{3}\sin^3\phi$	+0.0018	+0.0002	+0.0380	+0.0380
Sums	1.5708	+0.0003	+1.5677	+0.0791

$L=F\,(1.50708-0.0003)$ = 240.

Light along $EP=F(1.5708-1.5677)$ = 0.47

Light from Q outwards $=F(0.0791-0.0003)$ = 12.04

Total = 12.51

TABLE 4.—*Photometric measures of the Zodiacal Light in Jamaica, W. I.*

Dist. from Sun a.	L	S	r	r_s	Zenith distance. z.	Date (civil time).	Weight.	Notes.
°					°			
39	3.6	(1)	8.6	(5.7)	67	1912, Sept. 11, 4:40 a.	1	Starlight not obs. near Z. L. Light of Z. L. suddenly increased.
35	5.7	(1)	9.0	(5.7)	74	1912, Sept. 23, 4:40 a.	1	Starlight not obs. near Z. L.
38	6.6	1.4	9.1	6.5	78	1912, Oct. 18, 4:40 a.	2	Night poor.
38	3.2	0.9	7.4	5.4	80	1913, Feb. 25, 7:40 p.	2	Recommenced observations.
34	5.6	0.9	8.5	5.5	78	1914, Feb. 19, 7:30 p.	2	Recommenced observations.
30	3.8	0.7	7.2	4.7	81	1914, Mar. 24, 7:40 p.	1	Starlight suddenly increased.
32	12.3	1.1	9.4	6.0	79	1914, Mar. 25, 7:30 p.	2	Starlight not sufficiently observed.
34	9.0	1.8	9.9	7.1	77	1914, Apr. 18, 7:30 p.	3	Starlight brilliant.
35	9.1	1.5	10.0	6.7	75	1914, Apr. 24, 7:40 p.	3	Starlight brilliant. Fine display.
54	1.5	(1)	7.7	(5.7)	55	1912, Sept. 10, 4:30 a.	2	Starlight not observed. Very clear.
41	2.0	(1)	7.7	(5.7)	67	1912, Sept. 10, 4:40 a.	2	Starlight not observed. Very clear.
55	2.2	0.8	7.2	5.3	76	1912, Sept. 10, 8:00 p.	3	
59	1.1	0.7	6.8	4.7	55	1912, Sept. 15, 4:00 a.	1	Starlight not observed near Z. L.
41	5.4	1.3	9.0	6.3	75	1912, Oct. 19, 4:20 a.	2	
42	4.4	1.1	8.6	5.9	74	1912, Oct. 20, 4:20 a.	3	Very clear, fine display of the Z. L.
57	0.8	1.3	7.2	6.3	60	1913, Feb. 24, 8:00 p.	2	Very clear, but poor display.
56	1.3	0.8	7.0	5.0	60	1913, Feb. 25, 8:00 p.	2	Very clear, fair display.
54	0.9	0.9	6.8	5.4	60	1913, Feb. 27, 8:00 p.	2	Very clear, poor display.
53	1.2	0.9	7.2	5.5	57	1913, Feb. 28, 7:30 p.	2	Very clear, poor display.
44	4.0	1.1	8.5	6.0	74	1914, Mar. 25, 7:40 p.	2	
52	2.3	1.1	8.0	6.0	70	1914, Mar. 25, 8:20 p.	2	
48	3.0	(1)	8.2	(5.7)	70	1914, Mar. 26, 7:40 p.	1	Starlight not properly obs.
67	1.7	1.3	8.2	6.3	50	1912, Sept. 23, 4:00 a.	1	Observation poor.
78	0.7	(1)	7.0	(5.7)	35	1912, Oct. 19, 4:30 a.	1	Starlight observation much too low.
70	1.0	1.1	7.3	5.9	50	1912, Oct. 20, 4:00 a.	3	
78	1.3	0.9	7.3	5.4	58	1912, Oct. 30, 8:00 p.	3	
76	1.0	1.0	7.3	5.7	48	1912, Nov. 1, 7:20 p.	3	
89	0.8	1.2	7.2	6.1	57	1912, Nov. 6, 2:30 a.	3	
60	1.7	1.4	8.2	6.5	55	1914, Mar. 28, 7:40 p.	2	
92	0.5	1.1	6.8	5.9	22	1914, Apr. 18, 7:50 p.	3	Starlight brilliant.
99	0.5	1.8	7.6	7.1	50	1914, Apr. 22, 3:40 a.	3	
108	2.0	1.2	8.4	6.2	49	1914, Apr. 24, 3:10 a.	1	Much light in sky below Sagittarius.
111	0.1	1.6	7.0	6.8	7	1914, Apr. 24, 8:00 p.	1	Near zenith, difficult to observe.
101	0.9	1.1	7.4	6.0	28	1914, Apr. 26, 9:00 p.	3	
146	0.1	0.6	4.8	4.6	32	1912, Sept. 21, 4:40 a.	1	After dawn very thin cir. str. was seen about the sky.
146	0.2	1.3	6.6	6.3	20	1912, Sept. 23, 3:50 a.	3	
151	0.1	0.9	5.6	5.4	73	1914, Mar. 28, 3:20 a.	1	Too low.
149	0.2	1.6	7.0	6.8	62	1914, Mar. 30, 2:20 a.	2	Starlight brilliant; Z. L. rather low.
167	0.2	1.1	6.3	5.9	53	1914, Apr. 18, 8:10 p.	3	Starlight brilliant.
153	0.5	1.7	7.4	7.0	66	1914, Apr. 20, 2:30 a.	3	Long series of readings.
161	0.2	1.2	6.5	6.2	42	1914, Apr. 24, 2:50 a.	2	
139	0.3	1.6	7.2	6.8	23	1914, Apr. 24, 8:20 p.	3	E branch.
167	0.2	1.4	6.9	6.6	40	1914, Apr. 25, 2:40 a.	3	W branch.
174	0.4	(1)	6.3	(5.7)	60	1912, Sept. 10, 4:20 a.	1	Starlight not observed.
171	0.4	0.5	5.5	4.2	43	1912, Sept. 11, 3:20 a.	3	
179	0.7	0.7	6.2	4.7	56	1912, Sept. 15, 3:30 a.	3	Gegenschein bright and extends 20° along ecliptic.
175	0.6	1.3	7.1	6.3	55	1912, Sept. 23, 3:40 a.	3	
174	0.4	1.2	6.8	6.2	30	1912, Nov. 6, 1:30 a.	3	
180	0.2	1.2	6.6	6.2	20	1913, Mar. 6, 1:20 a.	2	Few observations, clouds came up.
172	0.5	1.1	6.8	6.0	50	1913, Mar. 16, 4:00 a.	3	
171	0.1	1.2	6.4	6.2	52	1914, Apr. 22, 3:20 a.	3	

TABLE 5.—*Seidel's table of the extinction of light by the atmosphere, increased 1/6.*

z	log R	z	log R	z	log R	z	log R
°		°		°		°	
13	0.000	32	0.010	51	0.057	70	0.223
14	1	33	12	52	.062	71	.238
15	1	34	13	53	.067	72	.254
16	1	35	14	54	.072	73	.272
17	1	36	15	55	.078	74	.291
18	2	37	16	56	.084	75	.313
19	3	38	17	57	.090	76	.336
20	3	39	18	58	.097	77	.361
21	4	40	20	59	.105	78	.389
22	4	41	22	60	.113	79	.419
23	5	42	24	61	.121	80	.453
24	5	43	27	62	.130	81	.499
25	6	44	30	63	.141	82	.565
26	6	45	33	64	.152	83	.641
27	7	46	36	65	.163	84	.719
28	7	47	40	66	.175	85	.798
29	8	48	44	67	.187	86	.880
30	8	49	48	68	.198	87	(0.964)
31	0.009	50	0.052	69	0.210	88	(1.048)

[Some observations on the zodiacal light, made by M. J. Donovan at Vicksburg, in February, 1914, and others by William E. Barron, also at Vicksburg, were referred to Mr. Maxwell Hall, and the following comments by him show how much good work can be done by those interested in this subject. We hope that other observers who are favorably situated will take an interest in this class of observations, as it is evident that such observations must be of great value.—C. A.]

NOTES ON MR. DONOVAN'S OBSERVATION OF THE ZODIACAL LIGHT, 1914, JAN. 27, 8:45 P. M.

[Dated Jamaica, W. I., June 22, 1914.]

Drawing a line between α Arietis and α Ceti we find that the point on the central axis of the zodiacal light was in longitude 39° with a latitude of ½° S., and that its breadth was 20°. Now the sun's longitude was 307° at that time, so that this observation gives us:

Long.	39°
Lat.	− ½°
Distance from sun	92°
Breadth	20°

According to MONTHLY WEATHER REVIEW, March, 1906, p. 4, Table 5, for long. 39° the corresponding lat. is −1¼°; so that the above observation is as nearly correct as possible.

Again, according to *Bulletin of the Mount Weather Observatory*, v. 6, pt. 3, p. 66, Table 4, or above figure 3, page 313, the breadth at 92° from the sun is 18°; so that the above observation is again as nearly as possible correct.

A few more of these observations made at different times of the year would have a high value.—*Maxwell Hall.*

NOTES ON MR. BARRON'S OBSERVATION OF THE ZODIACAL LIGHT.

[Dated Jamaica, W. I., June 22, 1914.]

If Mr. Barron were to procure a good set of maps and to note the position of the zodiacal light among the stars on a dark star-light night the observations he has made clearly show that his work would be of great value. He should observe as high above the horizon as possible to avoid the luminosity of the atmosphere near the horizon, which mingles with the zodiacal light and plays all kinds of tricks. Seen at its best the zodiacal light is a long tapering cone not more than 32° broad at its base, perfectly uniform and steady in figure and light; and if Mr. Barron were to start upon these lines he would soon become an expert.—*Maxwell Hall.*